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(54) **3-POINT POSITIONING DEVICE AND METHOD THEREOF**

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H03G 3/00 (2006.01)
G09G 5/00 (2006.01)

(52) **U.S. Cl.** **381/107; 345/156**

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See application file for complete search history.

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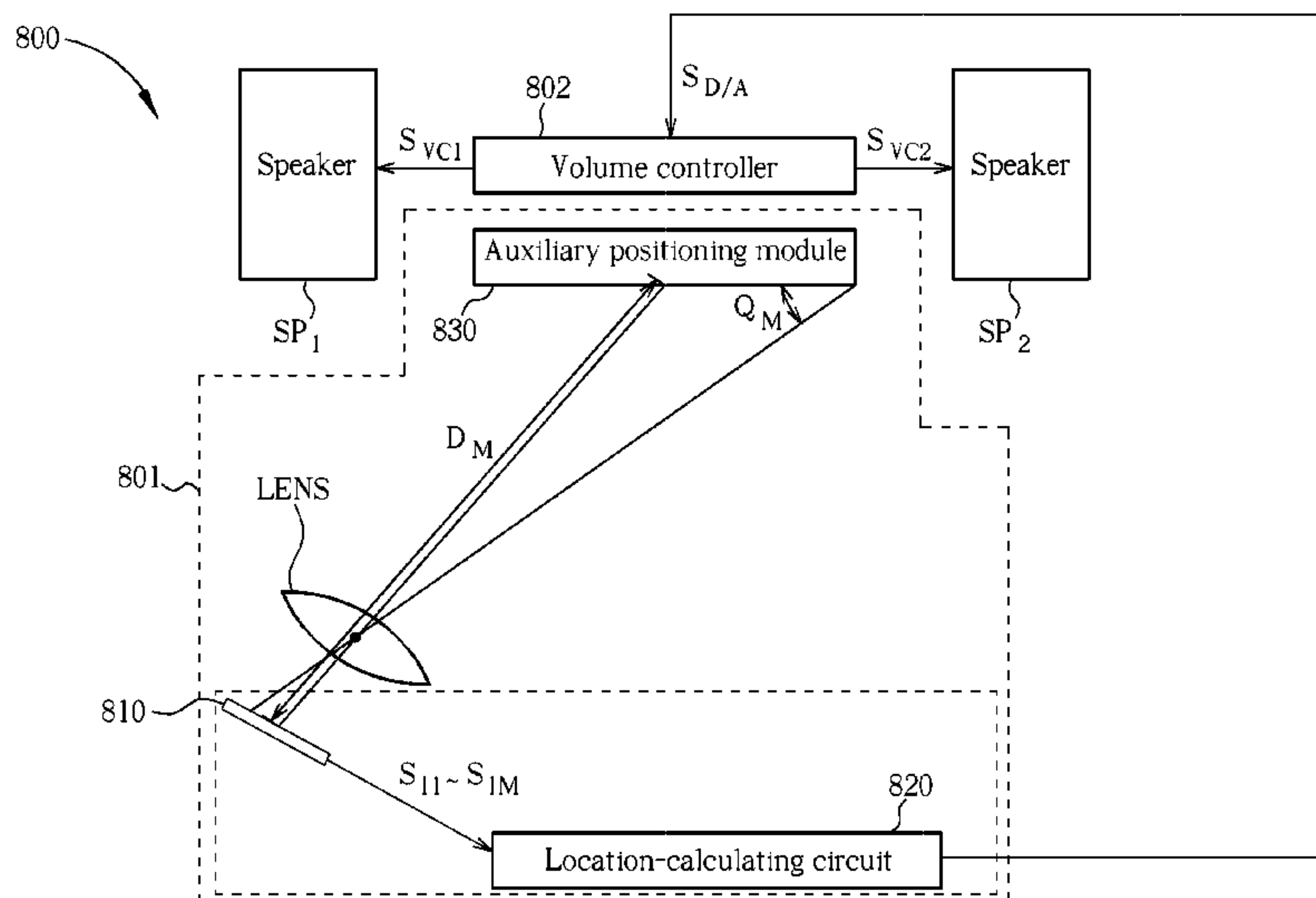
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(57) **ABSTRACT**

A 3-point positioning device senses a scene including an auxiliary positioning module by means of an image sensor, and accordingly generates a sensed image. The auxiliary positioning module comprises a first, a second, and a third auxiliary positioning units. By means of the sensed image, the 3-point positioning device recognizes a first, a second, and a third sensing units of the image sensor corresponding to the first, the second, and the third auxiliary positioning units. In this way, the 3-point positioning device can calculate out an absolute location of the auxiliary positioning module according to the locations or the received power of the first, the second, and the third sensing units.

30 Claims, 8 Drawing Sheets



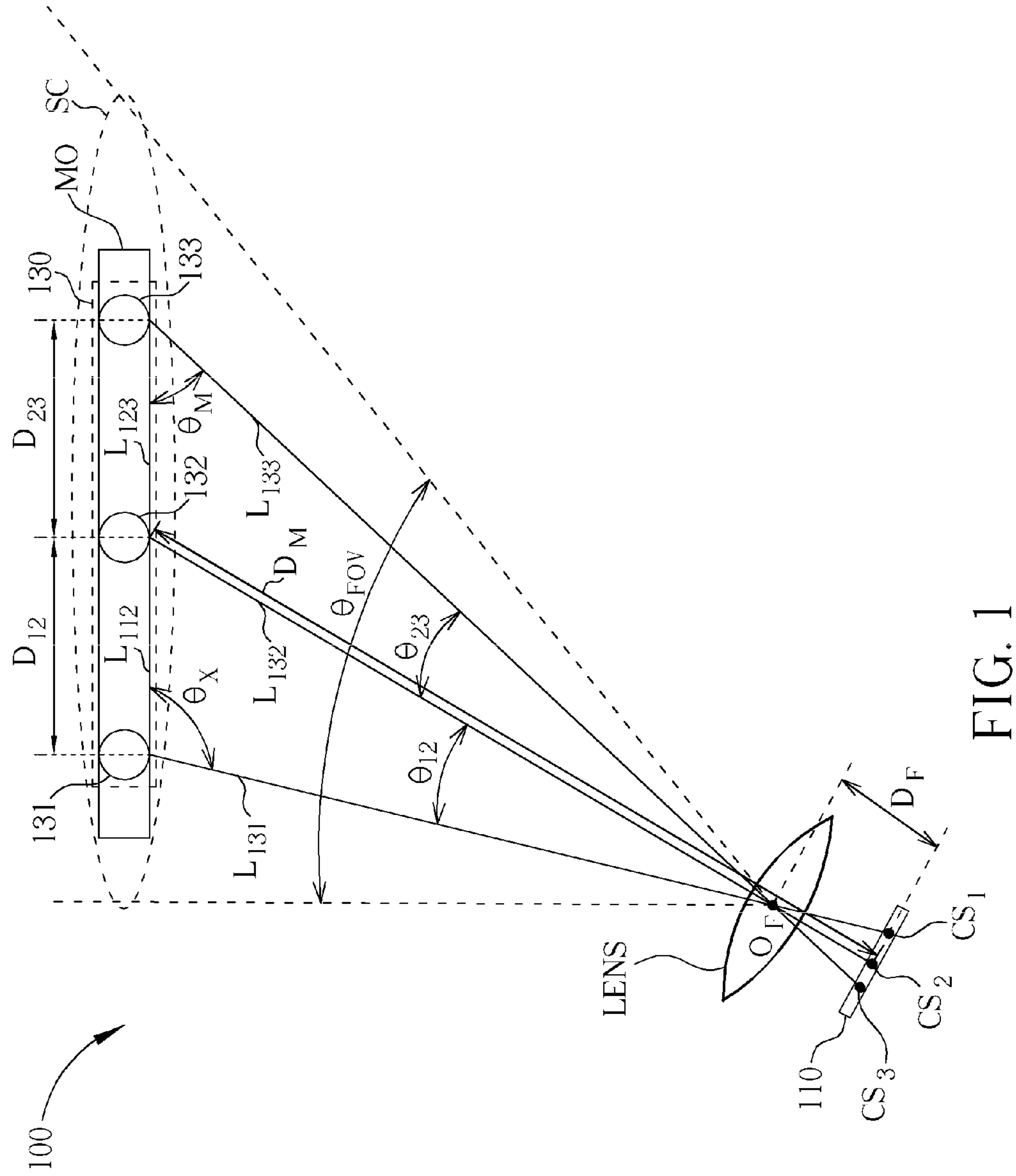


FIG. 1

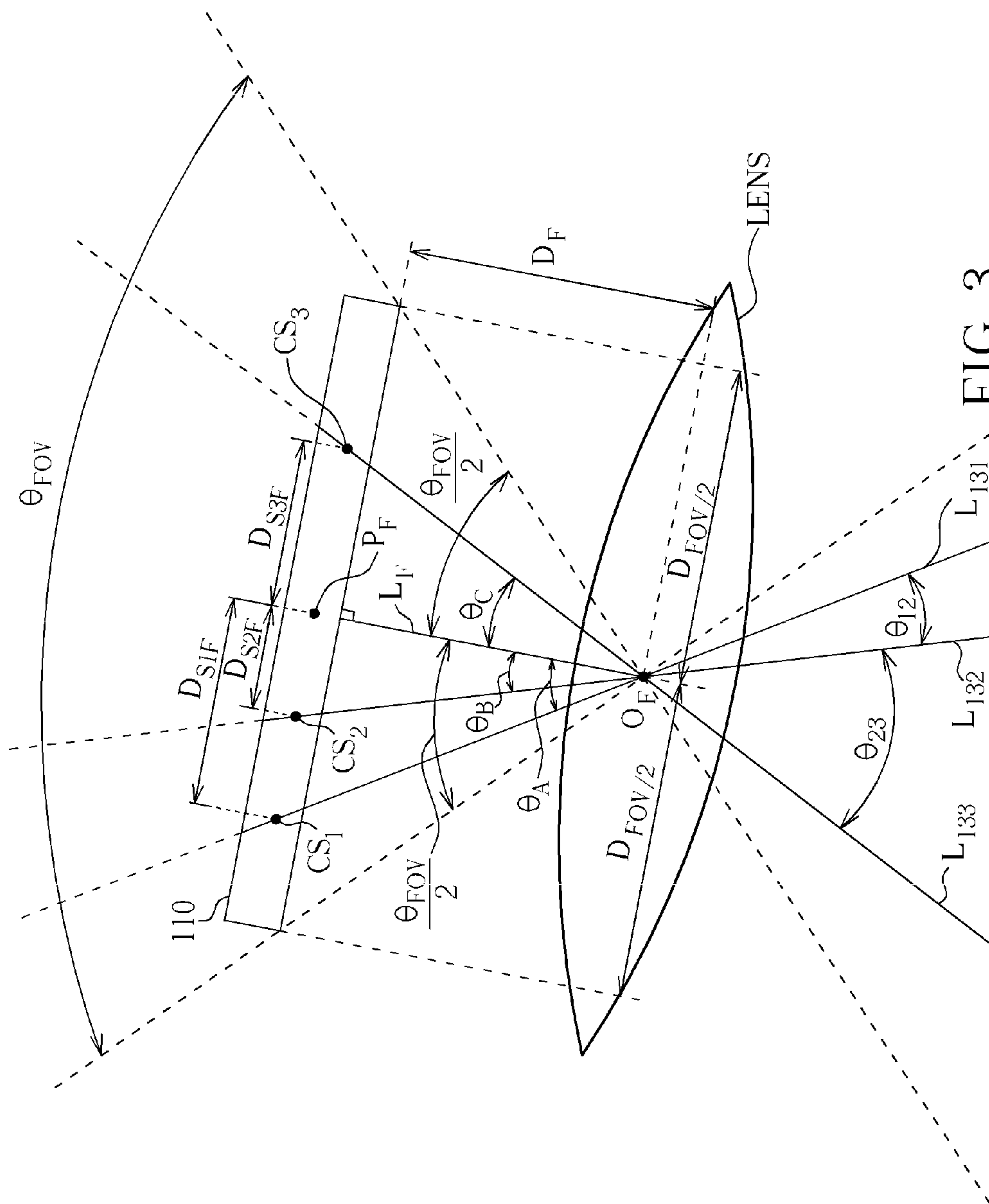


FIG. 3

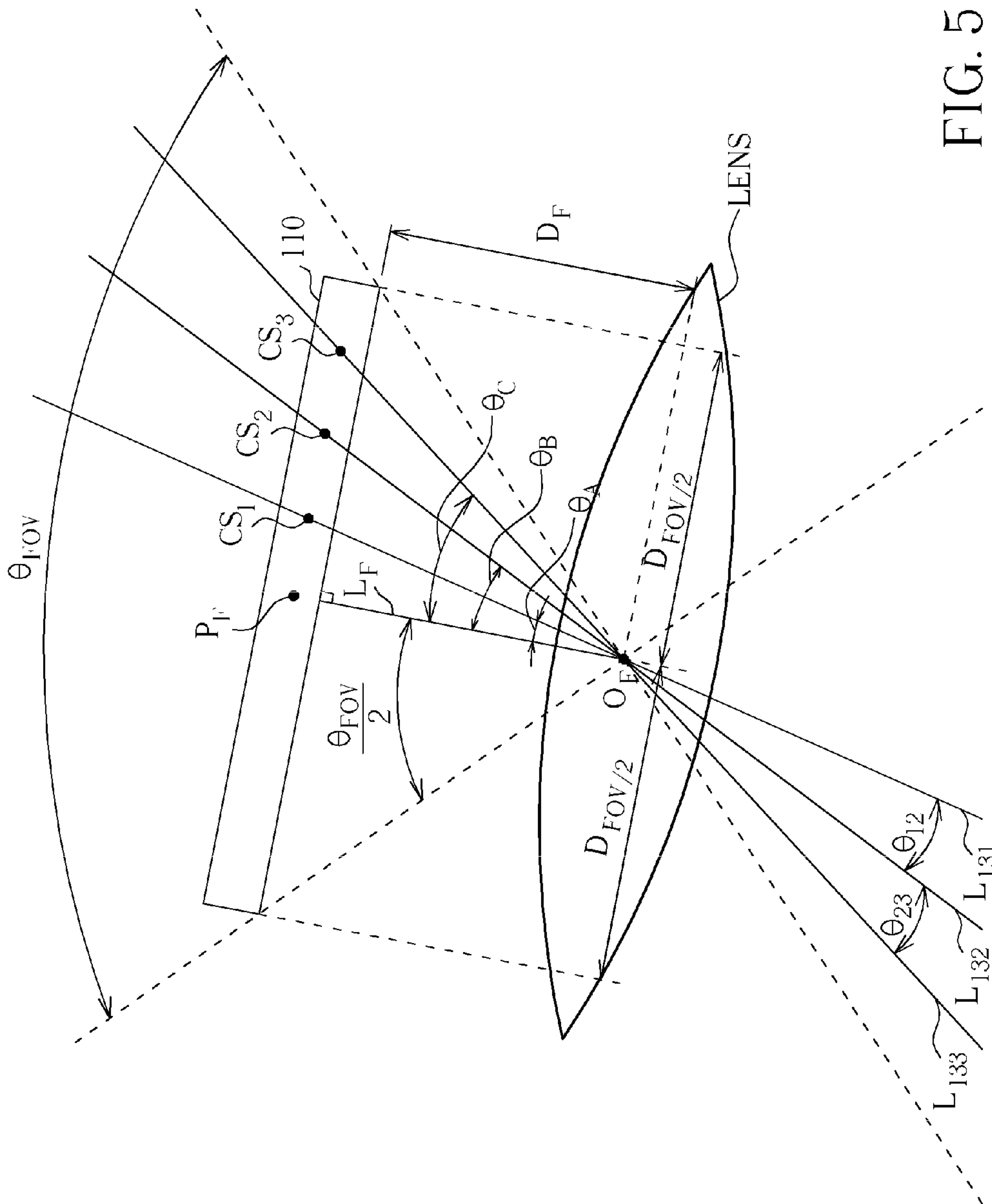


FIG. 5

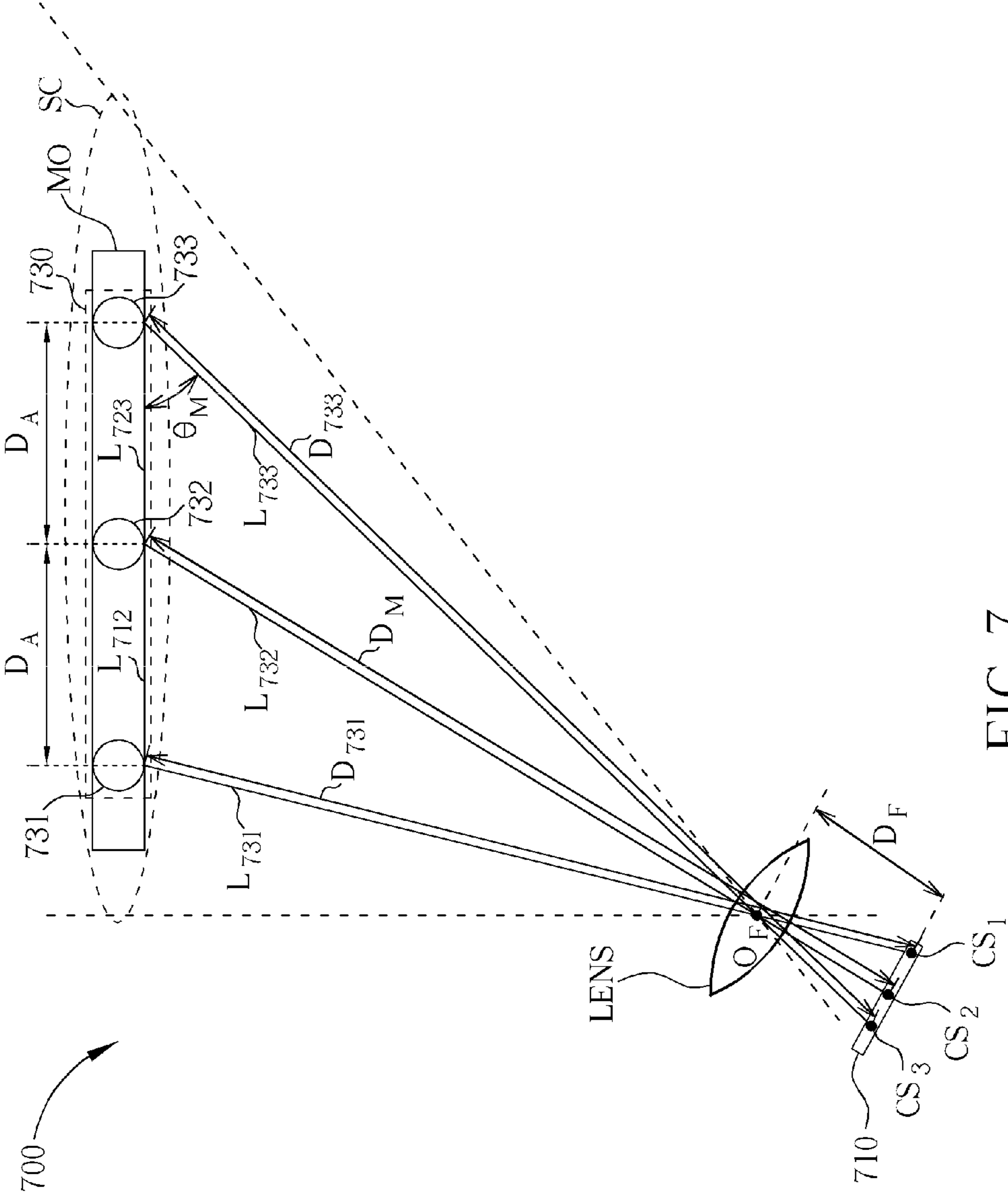


FIG. 7

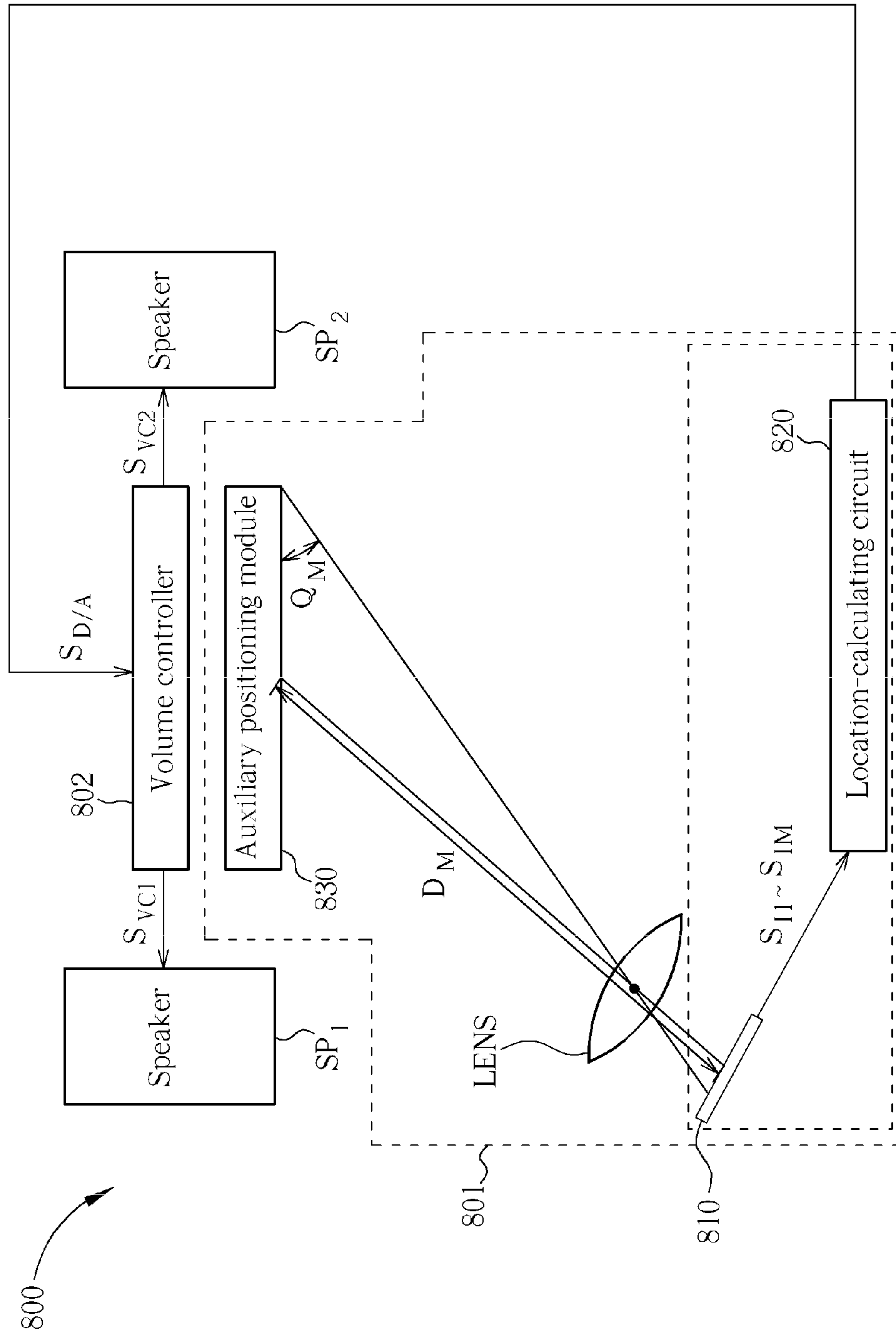


FIG. 8

3-POINT POSITIONING DEVICE AND METHOD THEREOF

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 61/176,488, filed on May 8, 2009 and entitled "optical distance and angle measurement with three light sources" the contents of which are incorporated herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is related to a positioning device, and more particularly, to a 3-point positioning device.

2. Description of the Prior Art

The conventional positioning device has been applied in the TV games or the computer games for the user having a better interactive experience. For example, in the Wii gaming console of Nintendo, the Wii joystick includes a conventional positioning device, so that the Wii game console can obtain the move distance and the move direction of the Wii joystick relative to a measured object (for instance, a display or a displaying screen), and the Wii game console can control the game proceeding according to the move distance and the move direction. Take a tennis game for example. When the user swings the Wii joystick, the Wii game console can obtain the relative move direction and the relative move distance of the Wii joystick by means of the conventional positioning device, so that the role controlled by the user can accordingly swing the tennis racket for hitting the ball. For instance, the longer the relative move distance per second obtained by the Wii game console is, the stronger the strength of the role hitting the ball is. Consequently, the flying speed of the ball is faster. Otherwise, the shorter the relative move distance per second obtained by the Wii game console is, the weaker the strength of the role hitting the ball is. Consequently, the flying speed of the ball is slower. In addition, the Wii game console can control the role corresponding to the user doing a forehand or a backhand tennis action according to the relative move direction.

SUMMARY OF THE INVENTION

The present invention provides a 3-point positioning device. The 3-point positioning device comprises an auxiliary positioning module, an image sensor, and a location-calculating circuit. The auxiliary positioning module comprises a first auxiliary positioning unit, a second auxiliary positioning unit, and a third auxiliary positioning unit. A first auxiliary positioning line is formed between the first auxiliary positioning unit and the second auxiliary positioning unit. A length of the first auxiliary positioning line is equal to a first predetermined distance. A second auxiliary positioning line is formed between the second auxiliary positioning unit and the third auxiliary positioning unit. A length of the second auxiliary positioning line is equal to a second predetermined distance. An included angle between the first and the second auxiliary positioning lines is a predetermined included angle. The image sensor is utilized for sensing a scene having a range including the first, the second, and the third auxiliary positioning units, and accordingly generating a sensed image. The range of the scene is determined by a predetermined view angle of the image sensor. The location-calculating circuit is utilized for receiving the sensed image so as to recognize a first sensing unit of the image sensor corresponding to the first

auxiliary positioning unit, a second sensing unit of the image sensor corresponding to the second auxiliary positioning unit, and a third sensing unit of the image sensor corresponding to the third auxiliary positioning unit, and calculating out a measured distance and a measured angle between the auxiliary positioning module and the image sensor according to the first, the second, and the third sensing units so as to accordingly output a distance/angle signal.

The present invention further provides a method of 3-point positioning. The method comprises providing a first, a second, and a third auxiliary positioning units of an auxiliary positioning module, and an image sensor, the image sensor sensing a scene for generating a sensed image, recognizing a first sensing unit of the image sensor corresponding to the first auxiliary positioning unit, a second sensing unit of the image sensor corresponding to the second auxiliary positioning unit, and a third sensing unit of the image sensor corresponding to the third auxiliary positioning unit, according to the sensed image, and calculating out a measured distance and a measured angle between the image sensor and the auxiliary positioning module according to the first, the second, and the third sensing units. The first, the second, and the third auxiliary positioning units are in a range of the scene. A first auxiliary positioning line is formed between the first auxiliary positioning unit and the second auxiliary positioning unit. A length of the first auxiliary positioning line is equal to a first predetermined distance. A second auxiliary positioning line is formed between the second auxiliary positioning unit and the third auxiliary positioning unit. A length of the second auxiliary positioning line is equal to a second predetermined distance. An included angle between the first and the second auxiliary positioning lines is a predetermined included angle.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram illustrating a 3-point positioning device according to a first embodiment of the present invention.

FIG. 2, FIG. 3, FIG. 4, and FIG. 5 are diagrams illustrating a method of calculating out the projection included angles and according to the present invention.

FIG. 6 is a diagram illustrating a 3-point positioning device according to the second embodiment of the present invention.

FIG. 7 is a diagram illustrating a 3-point positioning device according to the third embodiment of the present invention.

FIG. 8 is a diagram illustrating a speaker system of the present invention.

DETAILED DESCRIPTION

For the user having a better interactive experience, the present invention provides a 3-point positioning device capable of calculating out the absolute location of the user. In this way, the game console can provide a more realistic interactive experience according to the absolute location measured by the 3-point positioning device of the present invention.

Please refer to FIG. 1. FIG. 1 is a diagram illustrating a 3-point positioning device **100** according to a first embodiment of the present invention. The 3-point positioning device **100** comprises an image sensor **110**, a location-calculating circuit **120** (not shown in FIG. 1), and an auxiliary positioning module **130**. The 3-point positioning device **100** is utilized for

measuring a measured distance D_M and a measured angle θ_M between the auxiliary positioning module **130** and the image sensor **110**. When the auxiliary positioning module **130** and a measured object MO are disposed at the same location, the 3-point positioning device **100** can measure the measured distance D_M and the measured angle θ_M between the measured object MO and the 3-point positioning device **100**. For example, the measured object MO is a display or a displaying screen. When the image sensor **110** and the user are at the same location (for instance, the user holds the image sensor **110** of the 3-point positioning device **100**), the distance between the user and the display (the measured object MO) can be obtained by the 3-point positioning device **100**.

The auxiliary positioning module **130** comprises auxiliary positioning units **131**, **132**, and **133**. The auxiliary positioning units **131**, **132**, and **133** have the characteristics of recognition. For example, the auxiliary positioning units **131**, **132**, and **133** are Light-Emitting Diodes (LED) having a specific wavelength or a specific frequency (for instance, LEDs of infrared light), or, the auxiliary positioning units **131**, **132**, and **133** are objects having a specific pattern or a specific color, for the 3-point positioning device **100** to recognize the auxiliary positioning units **131**, **132**, and **133** in the sensed image signals of the image sensor **110**. In the present embodiment, the auxiliary positioning units **131**, **132**, and **133** are disposed on the measured object MO. An auxiliary positioning line L_{112} is formed between the auxiliary positioning units **131** and **132**. The length of the auxiliary positioning line L_{112} is equal to a predetermined distance D_{12} ; an auxiliary positioning line L_{123} is formed between the auxiliary positioning units **132** and **133**. The length of the auxiliary positioning line L_{123} is equal to a predetermined distance D_{23} . The auxiliary positioning line L_{112} is parallel to the auxiliary positioning line L_{123} .

The image sensor **110** is utilized for sensing a scene SC so as to generate a sensed image I. The sensed image I comprises image signals $S_{I1} \sim S_{IM}$. As shown in FIG. 1, the range of the scene SC that the image sensor **110** can sense is determined by a predetermined view angle θ_{FOV} of the image sensor **110**. The predetermined view angle θ_{FOV} of the image sensor **110** corresponds to the Field of View (FOV) of the image sensor **110**. The image sensor **110** comprises sensing units $CS_1 \sim CS_M$, wherein M represents a positive integer. Each sensing unit $CS_1 \sim CS_M$ of the image sensor **110** senses a corresponding part of the scene SC for generating the image signals $S_{I1} \sim S_{IM}$ of the sensed image I. For example, as shown in FIG. 1, the auxiliary positioning module is in the range of the scene SC. The sensing unit CS_1 senses the auxiliary positioning unit **131** in the range of the scene SC for generating the image signal S_{I1} ; the sensing unit CS_2 senses the auxiliary positioning unit **132** in the range of the scene SC for generating the image signal S_{I2} ; the sensing unit CS_3 senses the auxiliary positioning unit **133** in the range of the scene SC for generating the image signal S_{I3} . In addition, the lens LENS in FIG. 1 is utilized for focusing the light to the image sensor **110** so that the image sensor **110** can generate the sensed image I.

Furthermore, the measured distance D_M in FIG. 1 is illustrated to be the distance between the sensing unit CS_2 and the auxiliary positioning unit **132** for example. However, the measured distance D_M can be a distance between the sensing unit CS_1 and the auxiliary positioning unit **131**, or a distance between the sensing unit CS_3 and the auxiliary positioning unit **133**. Similarly, the measured angle θ_M of FIG. 1 is illustrated to be an included angle between the connecting line (formed between the sensing unit CS_2 and the auxiliary positioning unit **132**), and the auxiliary positioning line L_{123} , an included angle between the connecting line (formed between

the sensing unit CS_2 and the auxiliary positioning unit **132**) and the auxiliary positioning line L_{112} , or a included angle between the connecting line (formed between the sensing unit CS_1 and the auxiliary positioning unit **131**) and the auxiliary positioning line L_{112} .

The location-calculating circuit **120** is utilized for receiving the sensed image I (the image signals $S_{I1} \sim S_{IM}$) so as to recognize the sensing unit CS_1 corresponding to the auxiliary positioning unit **131**, the sensing unit CS_2 corresponding to the auxiliary positioning unit **132**, and the sensing unit CS_3 corresponding to the auxiliary positioning unit **133**. The location-calculating circuit **120** calculates out the measured distance D_M and the measured angle θ_M according to the sensing units CS_1 , CS_2 , and CS_3 , and accordingly generates a distance/angle signal $S_{D/A}$. The operational principle of the location-calculating circuit **120** is illustrated in detail as below.

In FIG. 1, a projection line L_{131} is formed between the sensing unit CS_1 and the auxiliary positioning units **131**; a projection line L_{132} is formed between the sensing unit CS_2 and the auxiliary positioning units **132**; a projection line L_{133} is formed between the sensing unit CS_3 and the auxiliary positioning units **133**. The measured distance D_M is defined as the distance between the sensing unit CS_2 and the auxiliary positioning unit **132**. The measured distance θ_M is an included angle between the projection line L_{133} and the auxiliary positioning line L_{123} . The projection lines L_{131} , L_{132} , and L_{133} cross with each other at a crossing point O_F . The location of the crossing point O_F is around at the center of the lens LENS. The distance between the crossing point O_F and the image sensor **110** is D_F . In addition, since the distance between the sensing unit CS_2 and the auxiliary positioning unit **132** is approximately equal to the distance between the crossing point O_F and the auxiliary positioning unit **132**, the measured distance D_M can represent not only the distance between the sensing unit CS_2 and the auxiliary positioning unit **132** but also the distance between the crossing point O_F and the auxiliary positioning unit **132**. The included angle between the projection lines L_{131} and L_{132} is defined as the projection included angle θ_{12} ; the included angle between the projection lines L_{132} and L_{133} is defined as the projection included angle θ_{23} . Since the projection lines L_{131} and L_{132} , and the measured object MO (or the auxiliary positioning lines L_{112} and L_{123}) form a triangle, the magnitude of the included angle θ_X between the projection line L_{131} and the measured object MO (or the auxiliary positioning lines L_{112} and L_{123}) is equal to $(\pi - \theta_M - \theta_{12} - \theta_{23})$, wherein π represents a sum of three internal angles of a triangle.

The relation between the measured distance D_M , the predetermined distance D_{12} , the predetermined distance D_{23} , the measured angle θ_M , and the projection included angles θ_{12} and θ_{23} can be represented as the following formulas according to the sine theorem:

$$D_{12}/\sin \theta_{12} = D_M/\sin \theta_X = D_M/\sin(\pi - \theta_M - \theta_{12} - \theta_{23}) \quad (1);$$

$$D_{23}/\sin \theta_{23} = D_M/\sin \theta_M = D_M/\sin \theta_M \quad (2);$$

therefore, as long as the location-calculating circuit **120** can obtain the magnitudes of the projection included angles θ_{12} and θ_{23} , the measured distance D_M and the measured angle θ_M can be calculated out according to the formulas (1) and (2).

Please refer to FIG. 2, FIG. 3, FIG. 4, and FIG. 5. FIG. 2, FIG. 3, FIG. 4, and FIG. 5 are diagrams illustrating a method of calculating out the projection included angles θ_{12} and θ_{23} according to the present invention. The end point projected by the crossing point O_F on the image sensor **110** is the middle point P_F of the image sensor **110**. A middle line L_F is formed between the crossing point O_F and the middle point P_F , and

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the length of the middle line is equal to the predetermined distance D_F . The middle line L_F is perpendicular to the surface of the image sensor **110**.

In FIG. 2, the middle point P_F is between the sensing units CS_1 and CS_2 . The distance between the sensing unit CS_1 and the middle point P_F is D_{S1F} , and the distance D_{S1F} can be obtained by means of summing the widths of the sensing units between the sensing unit CS_1 and the middle point P_F ; the distance between the sensing unit CS_2 and the middle point P_F is D_{S2F} , and the distance D_{S2F} can be obtained by means of summing the widths of the sensing units between the sensing unit CS_2 and the middle point P_F ; the distance between the sensing unit CS_3 and the middle point P_F is D_{S3F} , and the distance D_{S3F} can be obtained by means of summing the widths of the sensing units between the sensing unit CS_3 and the middle point P_F . In addition, the distance $D_{FOV/2}$ is a half of the width of the image sensor **110**, and the distance $D_{FOV/2}$ can be obtained by means of summing the widths of the sensing units at the left or the right sides of the middle point P_F . Thus, the middle-line included angle θ_A between the middle line L_F and the projection line L_{131} , the middle-line included angle θ_B between the middle line L_F and the projection line L_{132} , and the middle-line included angle θ_C between the middle line L_F and the projection line L_{133} can be represented as the following formulas:

$$\theta_A = \tan^{-1}[\tan(\theta_{FOV/2}) \times (D_{S1F}/D_{FOV/2})] \quad (3);$$

$$\theta_B = \tan^{-1}[\tan(\theta_{FOV/2}) \times (D_{S2F}/D_{FOV/2})] \quad (4);$$

$$\theta_C = \tan^{-1}[\tan(\theta_{FOV/2}) \times (D_{S3F}/D_{FOV/2})] \quad (5);$$

hence, the location-calculating circuit **120** can recognize the sensing units CS_1 , CS_2 , and CS_3 respectively corresponding to the auxiliary positioning units **131**, **132**, and **133** according to the sensed image I. Then the location-calculating circuit **120** obtains the distances D_{S1F} , D_{S2F} , and D_{S3F} according to the locations of the sensing units CS_1 , CS_2 , and CS_3 . The middle-line included angles θ_A , θ_B , and θ_C can be calculated out according to the formulas (3), (4), and (5). Since the projection included angle θ_{12} is equal to $(\theta_A + \theta_B)$ and the projection included angle θ_{23} is equal to $(\theta_C - \theta_B)$, as shown in FIG. 2, the location-calculating circuit **120** can calculate out the projection included angles θ_{12} and θ_{23} . In this way, the location-calculating circuit **120** can calculate out the measured distance D_M and the measured angle θ_M according to the formulas (1) and (2).

In FIG. 3, the method of calculating out the middle-line included angles θ_A , θ_B , and θ_C is similar to the method illustrated in FIG. 2. However, comparing with FIG. 2, in FIG. 3, the middle point P_F is between the sensing units CS_2 and CS_3 . Meanwhile, the projection included angle θ_{12} is equal to $(\theta_A - \theta_B)$ and the projection included angle θ_{23} is equal to $(\theta_C + \theta_B)$. In this way, the location-calculating circuit **120** can calculate out the middle-line included angles θ_A , θ_B , and θ_C according to the formulas (3), (4), and (5), and then calculate out the measured distance D_M and the measured angle θ_M according to the formulas (1) and (2).

In FIG. 4, the method of calculating out the middle-line included angles θ_A , θ_B , and θ_C is similar to the method illustrated in FIG. 2. However, comparing with FIG. 2, in FIG. 4, the sensing units CS_1 , CS_2 and CS_3 are all at the left side of the middle point P_F , and $\theta_C < \theta_B < \theta_A$. Also, the projection included angle θ_{12} is equal to $(\theta_A - \theta_B)$ and the projection included angle θ_{23} is equal to $(\theta_B - \theta_C)$. In this way, the location-calculating circuit **120** can calculate out the middle-line included angles θ_A , θ_B , and θ_C according to the formulas (3), (4), and

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(5), and then calculate out the measured distance D_M and the measured angle θ_M according to the formulas (1) and (2).

In FIG. 5, the method of calculating out the middle-line included angles θ_A , θ_B , and θ_C is similar to the method illustrated in FIG. 2. However, comparing with FIG. 2, in FIG. 5, the sensing units CS_1 , CS_2 and CS_3 are all at the right side of the middle point P_F , and $\theta_A < \theta_B < \theta_C$. Also, the projection included angle θ_{12} is equal to $(\theta_B - \theta_A)$ and the projection included angle θ_{23} is equal to $(\theta_C - \theta_B)$. In this way, the location-calculating circuit **120** can calculate out the middle-line included angles θ_A , θ_B , and θ_C according to the formulas (3), (4), and (5), and then calculate out the measured distance D_M and the measured angle θ_M according to the formulas (1) and (2).

Please refer to FIG. 6. FIG. 6 is a diagram illustrating a 3-point positioning device **600** according to the second embodiment of the present invention. The structure and the operation principle of the 3-point positioning device **600** are similar to those of the 3-point positioning device **100**. However, comparing with the 3-point positioning device **100**, in the 3-point positioning device **600**, the auxiliary positioning units **631**, **632**, and **633** are not disposed on the same line. The auxiliary positioning line L_{612} between the auxiliary positioning units **631** and **632** is not parallel to the auxiliary positioning line L_{623} between the auxiliary positioning units **632** and **633**. The angle included by the auxiliary positioning lines L_{612} and L_{623} is a predetermined included angle θ_Y . Since the auxiliary positioning lines L_{612} and L_{623} , and the projection lines L_{631} and L_{632} form a quadrangle, the magnitude of the angle included between the projection line L_{631} and the auxiliary positioning lines L_{612} is equal to $(2 \times \pi - \theta_M - \theta_{612} - \theta_{623} - \theta_Y)$. In this way, the relation between the measured distance D_M , the predetermined distance D_{612} , the predetermined distance D_{623} , the measured angle θ_M , and the projection included angles θ_{612} and θ_{623} can be represented as the following formulas according to the sine theorem:

$$D_{612}/\sin \theta_{612} = D_M/\sin \theta_X = D_M/\sin(2 \times \pi - \theta_M - \theta_{612} - \theta_{623} - \theta_Y) \quad (6);$$

$$D_{623}/\sin \theta_{623} = D_M/\sin \theta_M = D_M/\sin \theta_M \quad (7);$$

since the angles θ_{612} and θ_{612} can be calculated out by means of the method illustrated in FIG. 2, FIG. 3, FIG. 4, and FIG. 5, and the predetermined distance D_{612} and D_{623} is known, the 3-point positioning device **600** can calculate out the measured distance D_M and the measured angle θ_M by means of the location-calculating circuit **620** according to the formulas (6) and (7).

In addition, when the predetermined included angle θ_Y in the 3-point positioning device **600** is equal to π , the auxiliary positioning lines L_{612} and L_{623} are parallel to each other. Also, the structure and the principle of the 3-point positioning device **600** are similar to those of the 3-point positioning device **100**. The formula (6) is similar to the formula (1) when the predetermined included angle θ_Y in the formula (6) is substituted by π . Thus, the 3-point positioning device **100** is an equivalent device corresponding to the 3-point positioning device **600** when the predetermined included angle is equal to π .

Please refer to FIG. 7. FIG. 7 is a diagram illustrating a 3-point positioning device **700** according to the third embodiment of the present invention. The 3-point positioning device **700** comprises an image sensor **710**, a location-calculating circuit **720** (not shown in FIG. 7), and an auxiliary positioning module **730**. The 3-point positioning device **700** is utilized for measuring a measured distance D_M and a measured angle θ_M between the auxiliary positioning module **730** and the image

sensor **710**. When the auxiliary positioning module **730** and a measured object MO are disposed at the same location, the 3-point positioning device **700** can measure the measured distance D_M and the measured angle θ_M between the measured object MO and the 3-point positioning device **700**. The structure and the operation principle of the image sensor **710** are similar to the image sensors **610** and **110**, and thus will not be repeated again for brevity. In addition, in FIG. 7, the lens LEN is utilized for focusing the light to the image sensor **710**, so that the image sensor **710** can generate the sensed image I. The auxiliary positioning module **730** comprises auxiliary positioning units **731**, **732**, and **733**. In the present embodiment, it is assumed that the auxiliary positioning units **731**, **732**, and **733** are disposed on the measured object MO. The lengths of the auxiliary position lines L_{712} and L_{723} are both equal to the predetermined distance D_A . The auxiliary positioning units **731**, **732**, and **733** are all LEDs (for example, the LEDs of the infrared light). The lights emitted by the auxiliary positioning units **731**, **732**, and **733** have the same power PW_{LD} . The lights emitted by the auxiliary positioning units **731**, **732**, and **733** are all isotropic. That is, the auxiliary positioning units **731**, **732**, and **733** emit light uniformly. In addition, in FIG. 7, since the distance between the sensing unit CS_2 and the auxiliary positioning unit **732** is approximately equal to the distance between the crossing point O_F and the auxiliary positioning unit **732**, the measured distance D_M can represent not only the distance between the sensing unit CS_2 and the auxiliary positioning unit **732** but also the distance between the crossing point O_F and the auxiliary positioning unit **732**. Similarly, D_{731} can represent not only the distance between the sensing unit CS_1 and the auxiliary positioning unit **731** but also the distance between the crossing point O_F and the auxiliary positioning unit **731**; D_{733} can represent not only the distance between the sensing unit CS_3 and the auxiliary positioning unit **733** but also the distance between the crossing point O_F and the auxiliary positioning unit **733**. As a result, the powers PW_{731} , PW_{732} , and PW_{733} of the received lights of the sensing units CS_1 , CS_2 , and CS_3 , corresponding to the auxiliary positioning units **731**, **732**, and **733**, which are respectively related to the distance D_{731} between the sensor unit CS_1 and the auxiliary positioning units **731**, the distance D_M between the sensor unit CS_2 and the auxiliary positioning units **732**, and the distance D_{733} between the sensor unit CS_3 and the auxiliary positioning units **733**, can be represented as the following formulas:

$$[(PW_{731}/PW_{LD})/(PW_{732}/PW_{LD})]=D_M^2/D_{731}^2 \quad (8);$$

$$[(PW_{733}/PW_{LD})/(PW_{732}/PW_{LD})]=D_M^2/D_{733}^2 \quad (9);$$

the distance D_{731} is equal to $[D_M \times (PW_{732}/PW_{731})^{0.5}]$ according to the formula (8), and the distance D_{733} is equal to $[D_M \times (PW_{732}/PW_{733})^{0.5}]$ according to the formula (9), wherein (PW_{732}/PW_{731}) and (PW_{732}/PW_{733}) can be obtained by means of the image signals S_{I1} , S_{I2} , and S_{I3} of the sensed image I corresponding to the sensing units CS_1 , CS_2 , and CS_3 . For example, the image signals S_{I1} , S_{I2} , and S_{I3} respectively represent brightness B_{731} , B_{732} , and B_{733} . In this way, (PW_{731}/PW_{732}) is equal to (B_{731}/B_{732}) , and (PW_{733}/PW_{732}) is equal to (B_{733}/B_{732}) . Consequently, according to Apollonius' theorem and the triangle formed by the auxiliary positioning lines L_{712} and L_{723} , and the projection lines L_{731} and L_{733} , the measured distance D_M , the relation between the measure of the area of the triangle, and the distance D_{731} and D_{733} can be represented as the following formula:

$$(D_{731})^2 + (D_{733})^2 = 2 \times [(D_A)^2 + (D_M)^2] \quad (10);$$

In this way, the location-calculating circuit **720** can calculate out the measured distance D_M according to the formulas

(8), (9), and (10). Moreover, the measured distance D_M , the distances D_{731} and D_{733} , the predetermined distance D_A , and the measured angle θ_M can be represented as the following formula, according to Heron's formula and the triangle (formed by the auxiliary positioning lines L_{712} and L_{723} , and the projection lines L_{731} and L_{733}):

$$\frac{(1/2) \times D_A \times D_{733} \times \sin \theta_M}{(V - D_M)} = [V \times (V - D_A) \times (V - D_{733}) \times (V - D_M)] \quad (11);$$

wherein V is a half of the perimeter of the triangle (formed by the auxiliary positioning lines L_{712} and L_{723} , and the projection lines L_{731} and L_{733}), and V is equal to $[(1/2) \times (D_A + D_M + D_{733})]$. In this way, the location-calculating circuit **720** can calculate out the measured angle θ_M according to the formula (11).

In addition, when the 3-point positioning device of the present invention is applied for the game console, the game console can provide a better interactive experience to the user. Take the above-mentioned tennis game for example. When the user holds the joystick having the image sensor of the 3-point positioning device of the present invention, and the auxiliary positioning module of the 3-point positioning device of the present invention and the measured object (for instance, the display or the displaying screen) are at the same location, the game console can obtain the measured distance D_M and the measured angle θ_M between the user and the measured object. When the user moves, since the measured distance D_M changes as well, the game console can accordingly control the role in the game corresponding to the user moving. When the user swings the joystick, since the measured angle θ_M changes as well, the game console can accordingly control the role in the game corresponding to the user swinging the tennis racket. In this way, the user can control the role moving and swinging the tennis racket by means of the 3-point positioning device applied in the joystick, and the user has a more realistic interactive experience.

In addition, it is noticeable that, in the 3-point positioning device of the present invention (for example, the 3-point positioning devices **100**, **600**, or **700**), the measured distances between the image sensors **110**, **610**, and **710**, and the auxiliary positioning modules **130**, **630**, and **730** do not have to be the distances between the sensing unit CS_2 and the auxiliary positioning units **132**, **632**, and **732**. For example, the measured distance can be the distances between the sensing unit CS_1 and the auxiliary positioning units **131**, **631**, and **731**, or the distances between the sensing unit CS_3 and the auxiliary positioning units **133**, **633**, and **733**. The measured distances still can be calculated out by means above-mentioned method at the time. Similarly, the measured angles between the image sensors **110**, **610**, and **710**, and the auxiliary positioning modules **130**, **630**, and **730** do not have to be the included angles between the sensing unit CS_3 and the connecting lines formed by the sensing unit CS_3 and the auxiliary positioning units **133**, **633**, and **733**. For example, the measured angles between the image sensors **110**, **610**, and **710**, and the auxiliary positioning modules **130**, **630**, and **730**, can be the included angles between the projection lines L_{132} , L_{632} , and L_{732} (that is, the connecting lines between the sensing unit CS_2 and the auxiliary positioning units **132**, **632**, and **732**) and the auxiliary positioning lines L_{123} , L_{623} , and L_{723} , the included angles between the projection lines L_{132} , L_{632} , and L_{732} (that is, the connecting lines between the sensing unit CS_2 and the auxiliary positioning units **132**, **632**, and **732**) and the auxiliary positioning lines L_{112} , L_{612} , and L_{712} , or the included angles between the projection lines L_{131} , L_{631} , and L_{731} (that is, the connecting lines between the sensing unit CS_1 and the auxiliary positioning units **131**, **631**, and **731**) and the auxiliary

positioning lines L_{112} , L_{612} , and L_{712} . The measured angles still can be calculated out by means of the above-mentioned method at the time.

Please refer to FIG. 8. FIG. 8 is a diagram illustrating a speaker system 800 of the present invention. The speaker system 800 comprises a 3-point positioning device 801, a volume controller 802, and speakers SP_1 and SP_2 . The structure and the operation principle of the 3-point positioning device 801 are similar to those of the 3-point positioning devices 100, 600 or 700, and will not be repeated again for brevity. The auxiliary positioning module 830 is disposed between the speakers SP_1 and SP_2 . The location-calculating circuit 820 outputs the distance/angle signal $S_{D/A}$ according to the measured distance D_M and the measured angle θ_M . The volume controller 802 is utilized for receiving the distance/angle signal $S_{D/A}$ and outputting the volume-controlling signals S_{VC1} and S_{VC2} according to the measured distance D_M and the measured angle θ_M . The speakers SP_1 and SP_2 are utilized for outputting voices and adjusting the volumes of the voices respectively according to the volume-controlling signals S_{VC1} and S_{VC2} . For example, the image sensor 810 and the user are at the same location (for instance, the user holds a remote controller corresponding to the speaker system 800, and the image sensor 810 is disposed in the remote controller). Hence, when the location of the user changes, the volume controller 802 can adjust the volumes of the speakers SP_1 and SP_2 according to the location of the user (the location of the image sensor 810). The longer the measured distance D_M between the user and the speakers, the more the volume controller 802 increases the volumes of the speakers; otherwise, the shorter the measured distance D_M between the user and the speakers, the more the volume controller 802 decreases the volumes of the speakers. In this way, the volumes of the voices heard by the user do not vary with the location of the user. In addition, the volume controller 802 can determine if the user (the image sensor 810) and the speaker SP_1 (or SP_2) are at the same side of the auxiliary positioning module 830 or at different sides of the auxiliary positioning module 830 (as shown in FIG. 8, the user and the speaker SP_1 (or SP_2) are at the same side of the auxiliary positioning module 830). When the volume controller 802 determines the user and the speaker SP_1 are at the same side of the auxiliary positioning module 830, it represents that the distance between the user and the speaker SP_1 is shorter than the distance between the user and the speaker SP_2 . Therefore, the volume controller 802 reduces the volume of the speaker SP_1 and raises up the volume of the speaker SP_2 for maintaining the stereo of the speaker system 800; otherwise, when the volume controller 802 determines the user and the speaker SP_1 are at different sides of the auxiliary positioning module 830, it represents that the distance between the user and the speaker SP_1 is longer than the distance between the user and the speaker SP_2 . Therefore, the volume controller 802 raises up the volume of the speaker SP_1 and reduces the volume of the speaker SP_2 for maintaining the stereo of the speaker system 800.

In addition, as shown in FIG. 8, in the 3-point positioning device 801, the image sensor 810 and the location-calculating circuit 820 can be integrated into the same chip or realized in different chips. Similarly, in the 3-point positioning devices 100, 600, and 700, the image sensors 110, 610, and 710, and the location-calculating circuits 120, 620, and 720 can be integrated into the same chip or realized in different chips.

In conclusion, the 3-point positioning device provided by the present invention generates a sensed image by means of the image sensor sensing a scene including an auxiliary positioning module. The 3-point positioning device of the present

invention recognizes the sensing units corresponding to the auxiliary positioning module according to the sensed image. Thus, the absolute location of the auxiliary positioning module can be calculated out according to the locations or the received powers of the sensing units corresponding to the auxiliary positioning module. In addition, the game console can provide the user the more realistic interactive experience according to the measured distance and the measured angle measured by the 3-point positioning device of the present invention. In addition, the speaker system provided by the present invention can adjust the volumes of the speakers according to the location of the user for maintaining the stereo of the speaker system and the voices heard by the user do not vary with the location of the user, providing a great convenience.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A 3-point positioning device, comprising:
an auxiliary positioning module, comprising:

- a first auxiliary positioning unit;
 - a second auxiliary positioning unit; and
 - a third auxiliary positioning unit;
- wherein a first auxiliary positioning line is formed between the first auxiliary positioning unit and the second auxiliary positioning unit;
- wherein a length of the first auxiliary positioning line is equal to a first predetermined distance;
- wherein a second auxiliary positioning line is formed between the second auxiliary positioning unit and the third auxiliary positioning unit;
- wherein a length of the second auxiliary positioning line is equal to a second predetermined distance;
- wherein an included angle between the first and the second auxiliary positioning lines is a predetermined included angle;

an image sensor, for sensing a scene having a range including the first, the second, and the third auxiliary positioning unit, and accordingly generating a sensed image;

wherein the range of the scene is determined by a predetermined view angle of the image sensor; and

a location-calculating circuit, for receiving the sensed image so as to recognize a first sensing unit of the image sensor corresponding to the first auxiliary positioning unit, a second sensing unit of the image sensor corresponding to the second auxiliary positioning unit, and a third sensing unit of the image sensor corresponding to the third auxiliary positioning unit, and calculating a measured distance and a measured angle between the auxiliary positioning module and the image sensor according to positions of the first, the second, and the third sensing units so as to accordingly output at least a distance signal or an angle signal.

2. The 3-point positioning device of claim 1, wherein the first, the second, and the third auxiliary positioning units are Light-Emitting Diodes (LED) having a specific wavelength or a specific frequency, or the first, the second, and the third auxiliary positioning units are objects having a specific pattern or a specific color.

3. The 3-point positioning device of claim 1, wherein a first projection line is formed between the first sensing unit and the first auxiliary positioning unit; a second projection line is formed between the second sensing unit and the second auxiliary positioning unit; a third projection line is formed

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between the third sensing unit and the third auxiliary positioning unit; the first, the second, and third projection lines cross with each other at a crossing point; the crossing point is projected at a middle point of the image sensor; a middle line is formed between the crossing point and the middle point of the image sensor; the middle line is perpendicular to a surface of the image sensor.

4. The 3-point positioning device of claim 3, wherein the location-calculating circuit calculated out the measured distance and the measured angle according to following formulas:

$$D_{612}/\sin \theta_{612}=D_m/\sin(2\times\pi-\theta_M-\theta_{612}-\theta_{623}-\theta_Y); \text{ and}$$

$$D_{623}/\sin \theta_{623}=DM/\sin \theta_M;$$

wherein D_{612} represents the first predetermined distance; D_{623} represents the second predetermined distance; D_M represents the measured distance; θ_M represents the measured angle; π represents a sum of three internal angles of a triangle; θ_{612} represents a first projection included angle between the first and the second projection lines; θ_{623} represents a second projection included angle between the second and the third projection lines; θ_Y represents the predetermined included angle.

5. The 3-point positioning device of claim 4, wherein the location-calculating circuit calculates out a first middle-line included angle between the first projection line and the middle line, a second middle-line included angle between the second projection line and the middle line, and a third middle-line included angle between the third projection line and the middle line according to following formulas:

$$\theta_A=\tan^{-1}[\tan(\theta_{FOV}/2)\times(D_{S1F}/D_{FOV/2})];$$

$$\theta_B=\tan^{-1}[\tan(\theta_{FOV}/2)\times(D_{S2F}/D_{FOV/2})]; \text{ and}$$

$$\theta_C=\tan^{-1}[\tan(\theta_{FOV}/2)\times(D_{S3F}/D_{FOV/2})];$$

wherein θ_A represents the first middle-line included angle; θ_B represents the second middle-line included angle; θ_C represents the third middle-line included angle; D_{S1F} represents a distance between the middle point and the first sensing unit; D_{S2F} represents a distance between the middle point and the second sensing unit; D_{S3F} represents a distance between the middle point and the third sensing unit; $D_{FOV/2}$ represents a half of a width of the image sensor.

6. The 3-point positioning device of claim 5, wherein when the middle point is between the first and the second sensing units, the location-calculating circuit calculates out the first and the second projection included angles as following formulas:

$$\theta_{612}=\theta_A+\theta_B; \text{ and}$$

$$\theta_{623}=\theta_C-\theta_B.$$

7. The 3-point positioning device of claim 5, wherein when the middle point is between the second and the third sensing units, the location-calculating circuit calculates out the first and the second projection included angles as following formulas:

$$\theta_{612}=\theta_A-\theta_B; \text{ and}$$

$$\theta_{623}=\theta_C+\theta_B.$$

8. The 3-point positioning device of claim 5, wherein when the first, the second, and the third sensing units are at a same side of the middle point, and the first middle-line included angle is larger than second middle-line included angle, and

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the second middle-line included angle is larger than the third middle-line included angle, the location-calculating circuit calculates out the first and the second projection included angles as following formulas:

$$\theta_{612}=\theta_A-\theta_B; \text{ and}$$

$$\theta_{623}=\theta_B-\theta_C.$$

9. The 3-point positioning device of claim 5, wherein when the first, the second, and the third sensing units are at a same side of the middle point, and the third middle-line included angle is larger than the second middle-line included angle, and the second middle-line included angle is larger than the first middle-line included angle, the location-calculating circuit calculates out the first and the second projection included angles as following formulas:

$$\theta_{612}=\theta_B-\theta_A; \text{ and}$$

$$\theta_{623}=\theta_C-\theta_B.$$

10. The 3-point positioning device of claim 1, wherein the first predetermined distance is equal to the second predetermined distance; the predetermined included angle is equal to a sum of three internal angles of a triangle; the first, the second, and the third auxiliary positioning units are LEDs, and lights emitted by the first, the second, and the third auxiliary positioning units have a same power.

11. The 3-point positioning device of claim 10, wherein the location-calculating circuit calculates out the measured distance and the measured angle according to following formulas:

$$PW_{732}/PW_{731}=(D_{731})^2/(D_M)^2;$$

$$PW_{732}/PW_{733}=(D_{733})^2/(D_M)^2;$$

$$(D_{731})^2+(D_{733})^2=2\times[(D_A)^2+(D_M)^2];$$

$$(\frac{1}{2})\times D_A\times D_{733}\times \sin \theta_M=[V\times(V-D_A)\times(V-D_{733})\times(V-D_M)]; \text{ and}$$

$$V=(\frac{1}{2})\times(D_A\pm D_{733}+D_M);$$

wherein D_M represents the measured distance; θ_M represents the measured angle; D_A represents the first predetermined distance or the second predetermined distance; D_{731} represents a distance between the first sensing unit and the first auxiliary positioning unit; D_{733} represents a distance between the third sensing unit and the third auxiliary positioning unit; V represents a half of a perimeter of a triangle formed by the second auxiliary positioning line, the second projection line, and the third projection lines; PW_{731} represents a power of a received light of the first sensing unit; PW_{732} represents a power of a received light of the second sensing unit; PW_{733} represents a power of a received light of the third sensing unit.

12. The 3-point positioning device of claim 10, wherein the measured distance is a distance between the first sensing unit and the first auxiliary positioning unit, a distance between the second sensing unit and the second auxiliary positioning unit, or a distance between the third sensing unit and the third auxiliary positioning unit; the measured angle is an included angle between a connecting line formed between the second sensing unit and the second auxiliary positioning unit, and the first auxiliary positioning line, an included angle between a connecting line formed between the second sensing unit and the second auxiliary positioning unit, and the second auxiliary positioning line, a included angle between a connecting line formed between the first sensing unit and the first auxil-

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ary positioning unit, and the first auxiliary positioning line, or an included angle between a connecting line formed between the third sensing unit and the third auxiliary positioning unit, and the second auxiliary positioning line.

13. A speaker system, comprising:

a 3-point positioning device of claim 1;

a first speaker, for outputting a voice according to a first volume-controlling signal;

a second speaker, for outputting a voice according to a second volume-controlling signal; and

a volume controller, for receiving the distance signal and the angle signal, and outputting the first and the second volume-controlling signals according to the measured distance and the measured angle for adjusting volumes of the voices outputted by the first and the second speakers.

14. The speaker system of claim 13, wherein the longer the measured distance is, the more the volume controller increases the volumes of the voices outputted by the first and the second speakers; the shorter the measured distance is, the more the volume controller decreases the volumes of the voices outputted by the first and the second speakers.

15. The speaker system of claim 13, wherein the auxiliary positioning module is disposed between the first and the second speakers; when the volume controller determines that the image sensor and the first speaker at a same side of the auxiliary positioning module according to the measured distance and the measured angle, the volume controller decreases the volume of the voice outputted by the first speaker and the increases the volume of the voice outputted by the second speaker; when the volume controller determines that the image sensor and the first speaker at different sides of the auxiliary positioning module according to the measured distance and the measured angle, the volume controller increases the volume of the voice outputted by the first speaker and the decreases the volume of the voice outputted by the second speaker.

16. A method of 3-point positioning, comprising:

providing a first, a second, and a third auxiliary positioning units of an auxiliary positioning module, and an image sensor;

wherein a first auxiliary positioning line is formed between the first auxiliary positioning unit and the second auxiliary positioning unit;

wherein a length of the first auxiliary positioning line is equal to a first predetermined distance;

wherein a second auxiliary positioning line is formed between the second auxiliary positioning unit and the third auxiliary positioning unit;

wherein a length of the second auxiliary positioning line is equal to a second predetermined distance;

wherein an included angle between the first and the second auxiliary positioning lines is a predetermined included angle;

the image sensor sensing a scene for generating a sensed image;

wherein the first, the second, and the third auxiliary positioning units are in a range of the scene;

recognizing a first sensing unit of the image sensor corresponding to the first auxiliary positioning unit, a second sensing unit of the image sensor corresponding to the second auxiliary positioning unit, and a third sensing unit of the image sensor corresponding to the third auxiliary positioning unit, according to the sensed image; and

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calculating out a measured distance and a measured angle between the image sensor and the auxiliary positioning module according to the first, the second, and the third sensing units.

17. The method of claim 16, wherein the first, the second, and the third auxiliary positioning units are LEDs having a specific wavelength or a specific frequency, or the first, the second, and the third auxiliary positioning units are objects having a specific pattern or a specific color.

18. The method of claim 17, wherein a first projection line is formed between the first sensing unit and the first auxiliary positioning unit; a second projection line is formed between the second sensing unit and the second auxiliary positioning unit; a third projection line is formed between the third sensing unit and the third auxiliary positioning unit; the first, the second, and third projection lines cross with each other at a crossing point; the crossing point is projected at a middle point of the image sensor; a middle line is formed between the crossing point and the middle point of the image sensor; the middle line is perpendicular to a surface of the image sensor; the range of the scene is determined by a predetermined view angle of the image sensor.

19. The method of claim 18, wherein calculating out the measured distance and the measured angle between the image sensor and the auxiliary positioning module according to the first, the second, and the third sensing units comprises:

calculating out a first middle-line included angle between the first projection line and the middle line, a second middle-line included angle between the second projection line and the middle line, and a third middle-line included angle between the third projection line and the middle line, according to the predetermined view angle, the middle line, and the first, the second, and the third sensing units;

calculating out a first projection included angle between the first and the second projection lines, and a second projection included angle between the second and the third projection lines, according to the first, the second, and the third middle-line included angles; and

calculating out the measured distance and the measured angle, according to the predetermined angle, the first predetermined distance, the second predetermined distance, the first projection included angle, and the second projection included angle.

20. The method of claim 19, wherein the measured distance and the measured angle is calculated out according to following formulas:

$$D_{612}/\sin \theta_{612}=D_M/\sin(2\times\pi-\theta_M-\theta_{612}-\theta_{623}-\theta_Y); \text{ and}$$

$$D_{623}/\sin \theta_{623}=D_M/\sin \theta_M;$$

wherein D_{612} represents the first predetermined distance; D_{623} represents the second predetermined distance; D_M represents the measured distance; θ_M represents the measured angle; it represents a sum of three internal angles of a triangle; θ_{612} represents a first projection included angle between the first and the second projection lines; θ_{623} represents a second projection included angle between the second and the third projection lines; θ_Y represents the predetermined included angle.

21. The method of claim 20, wherein the first, the second, and the third middle-line included angles are calculated out according to following formulas:

$$\theta_A=\tan^{-1}[\tan(\theta_{FOV}/2)\times(D_{S1F}/D_{FOV/2})];$$

$$\theta_B=\tan^{-1}[\tan(\theta_{FOV}/2)\times(D_{S2F}/D_{FOV/2})]; \text{ and}$$

$$\theta_C=\tan^{-1}[\tan(\theta_{FOV}/2)\times(D_{S3F}/D_{FOV/2})];$$

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wherein θ_A represents the first middle-line included angle; θ_B represents the second middle-line included angle; θ_C represents the third middle-line included angle; D_{S1F} represents a distance between the middle point and the first sensing unit; D_{S2F} represents a distance between the middle point and the second sensing unit; D_{S3F} represents a distance between the middle point and the third sensing unit; $D_{FOV/2}$ represents a half of a width of the image sensor.

22. The method of claim 21, wherein when the middle point is between the first and the second sensing units, the first and the second projection included angles are calculated out according to following formulas:

$$\theta_{612} = \theta_A + \theta_B; \text{ and}$$

$$\theta_{623} = \theta_C - \theta_B.$$

23. The method of claim 21, wherein when the middle point is between the second and the third sensing units, the first and the second projection included angles are calculated out according to following formulas:

$$\theta_{612} = \theta_A - \theta_B; \text{ and}$$

$$\theta_{623} = \theta_C + \theta_B.$$

24. The method of claim 21, wherein when the first, the second, and the third sensing units are at a same side of the middle point, and the first middle-line included angle is larger than second middle-line included angle, and the second middle-line included angle is larger than the third middle-line included angle, the first and the second projection included angles are calculated out according to following formulas:

$$\theta_{612} = \theta_A - \theta_B; \text{ and}$$

$$\theta_{623} = \theta_B - \theta_C.$$

25. The method of claim 21, wherein when the first, the second, and the third sensing units are at a same side of the middle point, and the third middle-line included angle is larger than second middle-line included angle, and the second middle-line included angle is larger than the first middle-line included angle, the first and the second projection included angles are calculated out according to following formulas:

$$\theta_{612} = \theta_B - \theta_A; \text{ and}$$

$$\theta_{623} = \theta_C - \theta_B.$$

26. The method of claim 16, wherein the first predetermined distance is equal to the second predetermined distance; the predetermined included angle is equal to a sum of three internal angles of a triangle; the first, the second, and the third auxiliary positioning units are LEDs, and lights emitted by the first, the second, and the third auxiliary positioning units have a same power.

27. The method of claim 26, wherein the measured distance and the measured angle are calculated out according to following formulas:

$$PW_{732}/PW_{731} = (D_{731})^2 / (D_M)^2;$$

$$PW_{732}/PW_{733} = (D_{733})^2 / (D_M)^2;$$

$$(D_{731})^2 + (D_{733})^2 = 2 \times [(D_A)^2 + (D_M)^2];$$

$$(\frac{1}{2}) \times D_A \times D_{733} \times \sin \theta_M = [V \times (V - D_A) \times (V - D_{733}) \times (V - D_M)]; \text{ and}$$

$$V = (\frac{1}{2}) \times (D_A \pm D_{733} + D_M);$$

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wherein D_M represents the measured distance; θ_M represents the measured angle; D_A represents the first predetermined distance or the second predetermined distance; D_{731} represents a distance between the first sensing unit and the first auxiliary positioning unit; D_{733} represents a distance between the third sensing unit and the third auxiliary positioning unit; V represents a half of a perimeter of a triangle formed by the second auxiliary positioning line, the second projection line, and the third projection lines; PW_{731} represents a power of a received light of the first sensing unit; PW_{732} represents a power of a received light of the second sensing unit; PW_{733} represents a power of a received light of the third sensing unit.

28. The method of claim 16, wherein the measured distance is a distance between the first sensing unit and the first auxiliary positioning unit, a distance between the second sensing unit and the second auxiliary positioning unit, or a distance between the third sensing unit and the third auxiliary positioning unit; the measured angle is an included angle between a connecting line formed between the second sensing unit and the second auxiliary positioning unit, and the first auxiliary positioning line, an included angle between a connecting line formed between the second sensing unit and the second auxiliary positioning unit, and the second auxiliary positioning line, an included angle between a connecting line formed between the first sensing unit and the first auxiliary positioning unit, and the first auxiliary positioning line, or an included angle between a connecting line formed between the third sensing unit and the third auxiliary positioning unit, and the second auxiliary positioning line.

29. A 3-point positioning device, comprising:

an auxiliary positioning module, set on an object, the auxiliary positioning module comprising:

a first auxiliary positioning unit, set on the object;

a second auxiliary positioning unit, set on the object, wherein a first auxiliary positioning line is formed between the first auxiliary positioning unit and the second auxiliary positioning unit, and a length of the first auxiliary positioning line is equal to a first predetermined distance between the first auxiliary positioning unit and the second auxiliary positioning unit; and

a third auxiliary positioning unit set on the object, wherein a second auxiliary positioning line is formed between the second auxiliary positioning unit and the third auxiliary positioning unit, a length of the second auxiliary positioning line is equal to a second predetermined distance between the second auxiliary positioning unit and the third auxiliary positioning unit, and an included angle between the first and the second auxiliary positioning lines is a predetermined included angle;

an image sensor, for sensing a scene having a range including the first, the second, and the third auxiliary positioning unit, and accordingly generating a sensed image, wherein the range of the scene is determined by a predetermined view angle of the image sensor; and

a location-calculating circuit, for receiving the sensed image so as to recognize a first sensing unit of the image sensor corresponding to the first auxiliary positioning unit, a second sensing unit of the image sensor corresponding to the second auxiliary positioning unit, and a third sensing unit of the image sensor corresponding to the third auxiliary positioning unit, and calculating a measured distance and a measured angle between the auxiliary positioning module and the image sensor

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according to positions of the first, the second, and the third sensing units so as to accordingly output at least a distance signal or an angle signal.

30. The 3-point positioning device of claim **29**, wherein the first, the second, and the third auxiliary positioning units are

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used for providing light beams or reflecting light beams so as to be sensed by the image sensor.

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